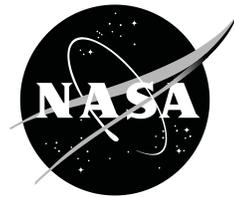


# **3...2...1...LIFTOFF!**

**An Educator's Guide With Activities in Science,  
Mathematics, Technology, and Language Arts**



National Aeronautics and Space Administration

NASA Johnson Space Center  
Houston, Texas

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# ***HOW TO USE THIS GUIDE***

The construction of the International Space Station (ISS) is one of humankind's most exciting and challenging endeavors. Numerous rocket launches are required to build this orbiting science laboratory.

The purpose of this curriculum supplement is to introduce students in the Early Childhood classroom to the International Space Station and the role rockets play in its construction. The guide uses these topics as the basis for interdisciplinary activities for the early learner.

The product begins with background information for educators. To better understand the activities that follow and to provide insight to students, educators should read these pages before beginning the lessons. This section provides information on the construction and the purpose of the International Space Station, as well as additional information on the history of rockets and the role of rockets in space station assembly.

Activities that follow the background information are designed to allow students to develop science, mathematics, technology, and English language arts skills. The activities in this guide are for use individually or as part of a more concentrated space or transportation unit. Educators may choose the sequence of lessons to best fit the requirements of their classrooms.

The activities require a minimum of preparation time and use materials that are usually available in the Early Childhood classroom. These activities emphasize hands-on involvement, data collection, observation, exploration, prediction, interpretation, problem solving, and development of language skills.

Each activity features objectives, a material list, educator information, procedures, and suggestions for assessment and enrichment. When appropriate, the guide provides illustrations and graphics for activities. Each activity correlates to national science, mathematics, technology, and English language arts standards. Because many lessons are interdisciplinary, matrix charts relating activities to national standards are included.

Following the activities, the guide includes a glossary of terms and acronyms.

Literature selections play an important role in classroom activities for the early learner. There are many excellent age-appropriate books available, both fact and fiction, on rockets and space exploration. Books can enhance activities in this guide. A list of titles, representing a small selection of appropriate books, follows the glossary.

NASA provides a variety of educational resources to support the activities contained in this publication. Resources include printed materials, electronic resources, videotapes, and software. This guide contains information on how to obtain these resources.

An Educator Reply Card, or evaluation, is included. To help improve this product in the future, please complete the form and make suggestions for changes or additions. Submit the evaluation by mail or electronically through the Internet site provided on the included evaluation card.



# PREFACE

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## *International Space Station*

The International Space Station (ISS) (Figure 1, page 73) represents the most complex international scientific endeavor in history. It is also the most ambitious construction project ever undertaken in space. Sixteen international partners, including the United States, are working together, sharing resources and expertise, to build this orbiting research facility. International partners include Canada, Russia, Japan, Brazil, and the eleven nations of the European Space Agency. In the United States, the organization responsible for building the ISS is the National Aeronautics and Space Administration (NASA).

Constructing the ISS is a complex and challenging task. The station, when complete, will be 108.5 meters wide and 88.4 meters long. It will be approximately the size of two football fields placed side by side. The completed station will weigh approximately 453,500 kilograms. There are no launch vehicles or rockets capable of carrying an object of this size into space at one time.

Individual components or pieces make up the space station. The components come in all shapes and sizes. Different nations build different components of the ISS. Each piece has a special purpose. Components are laboratories, living areas, and equipment and storage areas. Important

parts of the space station are the large, shiny solar arrays. These solar arrays provide power to the space station.

The living and working areas on board the completed space station will be about the size of three average American homes. Giant solar arrays will provide electricity for the space station. The electricity generated would power about 10 average American homes. Water will be recycled on the space station. While astronauts float in the microgravity environment, they will find the station to be at “shirt sleeve” temperatures.

Due to its size, the ISS must go to space in pieces. Rockets carry these pieces to space. At an average distance of approximately 407 kilometers above the Earth, traveling at 28,163 kilometers per hour, and circling the Earth every 90 minutes, humans must put these components together to build the station.

Construction of the Space Station began in 1998. Since then, the station has continued to grow in size. In 2000, the first international crew of three people went to live and work on board the station. Habitation of the space station marked the resumption of a long-term human presence in space.



The ISS is a science laboratory in space. The space station allows research in a microgravity environment. Research in biology, chemistry, physics, ecology, and medicine will result in benefits for people on Earth. ISS crews are already conducting scientific research on orbit.

The ISS will eventually be home to as many as seven people. Crews, who live and work on the station for four to six months, must be ferried back and forth to Earth. Rockets are needed to carry both cargo and people.

For more information and activities on the space station, check the educational materials at <http://spacelink.nasa.gov/products>.

## ***Space Shuttle***

American and Russian launch vehicles, or rockets, deliver individual ISS components to space. These vehicles also ferry crews, supplies, hardware, and station components from Earth to the station. NASA uses a reusable space transportation system (STS), the space shuttle (Figure 2, page 74, and Figure 3, page 75 ), to transport station components, hardware, supplies, and personnel to and from the ISS.

The space shuttle consists of several parts. One of the parts is the orbiter. The crew lives and works in the orbiter. There may be as many as seven people on a crew. The orbiter is the only part of the space shuttle that orbits the Earth. The orbiter needs special rockets to reach Earth orbit. Two solid rocket boosters attach to the external tank. The external tank attaches to the orbiter and supplies fuel to the three main rocket engines at the aft end of the orbiter.

The payload bay of the orbiter stores new components bound for the space station. A docking port in the payload bay allows the orbiter to join, or dock, with the ISS. After docking, a robotic arm

lifts a new piece or module out of the payload bay and attaches it to the station. Astronauts then perform spacewalks, or extravehicular activities (EVAs), to help attach new components to the ISS.

## ***Russian Rockets***

Two different Russian rockets also take people, supplies, and parts to the ISS. The Proton rocket sends pieces of the space station to space (Figure 4, page 76). A Proton rocket launched the first ISS component, the Russian-built Zarya control module.

A smaller Russian rocket, the Soyuz (Figure 5, page 77), takes crews and cargo to and from the station. The crew, usually three people, travels in a small Soyuz capsule launched on a Soyuz rocket. When it arrives at the station, the capsule docks to a port on a Russian-built component. In addition, a Soyuz rocket launches a Progress spacecraft.

The Progress does not carry people; it carries supplies, or cargo, to and from the station. The Progress also docks to a port on a Russian-built part of the ISS. In the future, a variety of new vehicles will visit the station to ferry crews and supplies.

## ***ISS Completion***

Building the ISS will take many years. Its construction will require more than 40 launches of the space shuttle, Proton, and Soyuz rockets. Assembling more than 100 space station components will require the use of robot technology and many hours of spacewalks by astronauts. When complete, scientific research will continue on the station for many years.

For more information on the International Space Station and the space shuttle, visit <http://spaceflight.nasa.gov>. Information on



launches, missions, crews, and shuttle and station sightings is available at the Spaceflight web site.

## ***Rocket History***

American and Russian rockets carry the parts and the crews needed to construct the ISS in space. The space shuttle and the Proton and Soyuz rockets are all necessary for its construction. These modern rockets are the result of centuries of experimentation by people around the world.

Although it is not clear when true rockets were first developed, historical records indicate that the Chinese developed simple rockets as early as the 13<sup>th</sup> century. They invented a form of gunpowder to create fireworks for special events. Eventually, the Chinese put gunpowder in a bamboo tube. When lit, this gunpowder-filled tube launched, creating a simple rocket.

More than 300 years ago, in the 17<sup>th</sup> century, scientists began to study rockets. Sir Isaac Newton (1642-1727) was a scientist who tried to explain how rockets work. He stated three scientific principles, called Newton's Laws of Motion, which describe the motion of objects, either on Earth or in space. To successfully build rockets, scientists have to understand these laws.

Early in the 20<sup>th</sup> century, one of the scientists who conducted rocket experiments was an American named Robert Goddard (1882-1945). People call

Goddard "the father of modern rocketry." His research helped give humans the ability to send rockets to space. As a result of the research of Newton and Goddard, modern rocket scientists are able to design and build sophisticated rockets like the space shuttle, the Proton, and the Soyuz.

Modern rockets took the first humans to space and then to the Moon. Rockets launch satellites into orbit around the Earth and send unmanned spacecraft to explore the universe. Rockets are necessary to transport crews, parts, and materials to build the International Space Station.

For more information on the history of rockets and additional rocket activities, visit the Spacelink web site at <http://spacelink.nasa.gov>.

## ***NASA Educational Resources***

NASA provides a variety of educational resources to support these lessons on the ISS and rockets. The section of this guide titled *NASA Resources for Educators* contains detailed information on how to obtain these materials, including visual resources, videotapes, Internet sites, and instructional products. For additional information on how to access NASA educational resources, contact the Educator Resource Center that serves your area. A listing of these offices is found in the resource section of this guide.

